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U. S. DEPARTMENT OF AGRICULTURE.

 FARMERS' BULLETIN No. 107.

Experiment Station Work,

XIII.

FERTILIZER REQUIREMENTS OF CROPS.

PERSIMMONS.

FORCING RHUBARB.

GRINDING CORN FOR COWS.

WASTE IN FEEDING CORNSTALKS.

MOLASSES FOR FARM ANIMALS.

FEEDING DUCKS.

COST OF RAISING CALVES.

FEEDING CALVES WITH MILK OF TUBERCULOUS COWS.

KILLING THE GERMS OF TUBERCULOSIS IN MILK.

ROPHY MILK AND CREAM.

DAIRY SALT.

 PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.



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- II. (Farmers' Bul. 65).—Common Crops for Forage; Stock Melons; Starch in Potatoes; Crimson Clover; Geese for Profit; Cross Pollination; A Germ Fertilizer; Lime as a Fertilizer; Are Ashes Economical? Mixing Fertilizers.
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EXPERIMENT STATION WORK.

Editor: W. H. BEAL.

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EXPERIMENT STATION WORK—XIII.¹

FERTILIZER REQUIREMENTS OF CROPS.

In those regions where fertilizers are extensively used it is of the greatest importance to know with reasonable exactness the varying fertilizer requirements of different soils and crops in order to get the greatest return from the fertilizers applied. A commonly accepted method of securing this information is by means of plat experiments, in which the crops are grown on the different soils with the various fertilizers whose merits are to be tested. Many of the experiment stations have carried out extensive experiments of this kind, in cooperation with farmers on a great variety of soils and crops, and have thus brought out certain general facts, especially with regard to particular regions having soils of a similar character, which may be profitably used in practice. But since there are wide variations in the fertilizer requirements of soils as well as of crops, it is not safe to blindly apply the results of such experiments on one soil in the fertilizing of another. The safest plan is for each farmer to test the question for himself on his own soil,² using the results of experiments on other soils only as general guides in the use of fertilizers in default of such tests.

During the past ten years the Massachusetts Experiment Station has conducted fertilizer experiments with a number of different crops on a variety of soils in different parts of Massachusetts. A recent bulletin summarizes the results of some 30 such experiments on corn, 6 on oats, 12 on grass and clover, and 1 each on rye, soy beans, turnips, and cabbage. The conclusions reached can not fail to be of great value to the

¹ This is the thirteenth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

² See also U. S. Dept. Agr., Farmers' Bul. 69 (Experiment Station Work—III), p. 26.

farmers of Massachusetts and other regions with similar crop and soil conditions, but they should be applied with caution in other regions.

Where these experiments were made "the farmers, as a rule, sell no grain to carry away phosphates. They do sell hay, straw, vegetables, and fruits, all of which contain more potash than phosphoric acid. Many of the farmers are milk producers. They buy and feed large quantities of wheat bran, cotton-seed meal, gluten meal, oats, etc. These foods are rich in phosphates and nitrogen, and consequently the manures of home production are rich in these elements. * * * Analyses of plants and agricultural products show them, as a rule, to contain much more potash than phosphoric acid; while the fertilizers in most cases contain the latter in much the larger quantity." The conditions, therefore, favor the exhaustion of the potash of the soil and the excessive accumulation of phosphoric acid. Such conditions obtain in many regions of the United States.

The questions studied in the experiments were:

(1) To what extent and in what way do the plant-food requirements of different crops cultivated in rotation vary?

(2) Are the so-called complete "special" fertilizers offered upon our markets rationally compounded?

(3) Is the practice of our farmers in so frequently using phosphates alone wise, and calculated to insure the largest possible crops at the least cost?

The conclusions reached regarding the fertilizer requirements of the different crops experimented with were as follows:

Corn.—(1) This crop profits particularly from an application of potash salts [especially the muriate].

(2) The so-called "special" fertilizers for corn offered in Massachusetts markets are not rightly compounded. The average of such fertilizers in 1897 was: Nitrogen, 2.80 per cent; phosphoric acid, 11.31 per cent; potash, 3.57 per cent. The best contained: Nitrogen, 4.04 per cent; phosphoric acid, 11.80 per cent; potash, 9.94 per cent. The following proportions [are suggested]: Nitrogen, 3; phosphoric acid, 4, and potash, 11.

(3) The use of phosphates to supplement natural supplies of manures is not wise and does not promise to insure largest crop at least cost. * * *

Oats.—(1) The requirements of oats are in a marked degree different from those of corn upon the same soil. The latter requires potash; oats are remarkable for their ability to extract potash from the natural stores of the soil and profit from an application of nitrogen.

(2) Fertilizers for oats offered in our markets are not properly compounded. The average of those offered in 1897 contained: Nitrogen, 2.65; phosphoric acid, 11.96, and potash 4.90 per cent. The best contained: Nitrogen, 8.92; phosphoric acid, 18.68, and potash, 10 per cent. The following proportions [are suggested]: Nitrogen, 4; phosphoric acid, 3, and potash, 5 parts.

(3) The extensive use of phosphates alone for oats does not promise to be profitable. * * *

Grass and clover.—(1) Grass is similar in its requirements to oats (nitrogen in the form of nitrate of soda most beneficial); the clovers are to a considerable extent similar to corn in their dependence upon potash, but are more benefited by phosphoric acid than the latter.

(2) The "special" fertilizers for grass lands are not properly compounded whether for grasses or for the clovers. They contain too little nitrogen for the former; too

little potash for the latter. The average of those offered in 1893 was: Nitrogen, 4.02; phosphoric acid, 8.30, and potash, 5.52 per cent. For use where timothy is to be grown, a fertilizer supplying the elements in the following proportions [is recommended]: Nitrogen, 8; phosphoric acid, 3; potash, 3. For manuring where clover is desired: Nitrogen, 2; phosphoric acid, 5, and potash, 10.

(3) Maximum crops of hay at minimum cost, whether of grasses or clovers, are not to be looked for from the application of phosphates. * * *

Rye.—(1) Rye shows a more general dependence upon applied fertilizers than the other crops under experiment. The difference in the degree of effectiveness of the elements applied (nitrogen, phosphoric acid, and potash) is not great.

(2) The same fertilizers are offered in Massachusetts, as a rule, under the name of "grain" fertilizers, both for oats and rye. This is not warranted by the facts brought out concerning the two crops. Nitrogen should be most prominent in fertilizers for oats, while for rye the fertilizer must be richer in potash.

(3) The results of the experiment do not encourage the belief that one-sided phosphate manuring for rye will give most profitable results. * * *

White mustard, cabbage, and Swedish turnips.—(1) These crops (all belonging to the same family) are markedly different in their requirements from any of the others experimented with, responding in highest degree to an application of phosphate, which none of the others have done.

(2) There appear to be but few "special" fertilizers upon our markets for these crops.

(3) The use of phosphates to supplement farm manures for these crops promises to be profitable. * * *

Soy beans.—(1) This crop differs widely in its requirements from both the rye and the mustard which had preceded it.

(2) No "specials" are made for this crop in Massachusetts, but fertilizers for it should be rich in potash.

In general these experiments show, as stated in the beginning, that there is the widest difference in the fertilizer requirements of different crops cultivated on the same soil—corn, clovers, rye, and soy beans appearing to especially require potash; grasses and oats, nitrogen; and mustard, cabbages, and Swedish turnips, phosphoric acid. The last crops are apparently the only ones experimented with that would be benefited by an application of phosphates to supplement farm manure.

It also appears from the experiments that the complete "special" fertilizers found in the market as a rule contain more phosphoric acid than is required by most farm crops, but furnish less nitrogen than is demanded by oats and grass.

"Under existing conditions farmers are advised to purchase fertilizer materials and to make their own mixtures rather than to purchase mixed or complete special fertilizers. This course is believed to be advisable for two reasons: First, because the 'specials' are not properly compounded, and, second, because the needed plant food can be thus procured at lower cost."¹

Taking into consideration the March, 1899, market prices of fertilizers and the results of the above experiments, the following mixtures are recommended in the bulletin above referred to. The quantities given are designed for one acre.

¹ U. S. Dept. Agr., Farmers' Buls. 65 and 84 (Experiment Station Work, II, p. 27; VII, p. 5).

1. For corn on sod land in fair condition:	Pounds.
Nitrate of soda	100
Dry ground fish.....	200
Acid phosphate	250
Muriate of potash (or high-grade sulphate)	220

These materials furnish about: Nitrogen, 30 pounds; phosphoric acid, 40 pounds, and potash, 110 pounds.

2. For corn on land rather poor in organic matter:	Pounds.
Nitrate of soda	200
Dry ground fish.....	200
Tankage.....	100
Acid phosphate	200
Muriate of potash (or high-grade sulphate).....	250

These materials furnish about: Nitrogen, 42 pounds; phosphoric acid, 50 pounds, and potash, 125 pounds.

3. For corn in connection with farm manure:	Pounds.
Nitrate of soda	50
Dry ground fish.....	100
Acid phosphate	100
Muriate of potash (or high-grade sulphate).....	100

These materials furnish about: Nitrogen, 14½ pounds; phosphoric acid, 21½ pounds, and potash, 50 pounds.

4. For oats on land in good condition:	Pounds.
Nitrate of soda	125
Acid phosphate	100
Muriate of potash (or high-grade sulphate).....	50

These materials furnish nitrogen, 20 pounds; phosphoric acid, 14 pounds, and potash, 25 pounds.

5. For oats on land in low condition:	Pounds.
Nitrate of soda	175
Dried blood.....	100
Acid phosphate.....	200
Muriate of potash (or high-grade sulphate)	90

These materials will furnish about: Nitrogen, 37 pounds; phosphoric acid, 27 pounds, and potash, 45 pounds.

6. For mixed grasses or timothy:	Pounds.
Nitrate of soda	150
Tankage.....	125
Acid phosphate	50
Muriate of potash (or high-grade sulphate)	25

These materials will furnish about: Nitrogen, 32 pounds; phosphoric acid, 15 pounds, and potash, 13 pounds.

7. For mowings with considerable clover:	Pounds.
Nitrate of soda	100
Acid phosphate.....	300
Muriate of potash (or high-grade sulphate)	160

These materials furnish about: Nitrogen, 16 pounds; phosphoric acid, 40 pounds, and potash, 80 pounds.

8. For rye:	Pounds.
Nitrate of soda	125
Acid phosphate	150
Muriate of potash (or high-grade sulphate)	125

These materials furnish: Nitrogen, 19 pounds; phosphoric acid, 20 pounds, and potash, 63 pounds.

9. For cabbages or Swedish turnips:	Pounds.
Nitrate of soda	150
Dried blood.....	200
Dry ground fish.....	400
Bone meal	200
Acid phosphate	500
Sulphate of potash (high grade)	250

Furnishing nitrogen, 70 pounds; phosphoric acid, 141 pounds, and potash, 125 pounds.

10. For soy beans:	Pounds.
Nitrate of soda	100
Dry ground fish.....	150
Acid phosphate	300
Sulphate of potash (high grade).....	200

Furnishing nitrogen, 27 pounds; phosphoric acid, 52 pounds, and potash, 100 pounds.

The continuous use of muriate of potash may so far deplete the soil of lime that an occasional application of this material may be required in case of such use. The sulphate of potash may be a safer material to use where a growth of clover is desired than the muriate, and therefore it may often be wise to use the sulphate in such formulas as are given above where muriate is specified. The high-grade sulphate should be selected.

These materials should as a rule be mixed just before use, and applied broadcast (after plowing) and harrowed in just before planting the seed. Where nitrate of soda is to be used in quantities in excess of 150 pounds per acre, one-half the amount of this salt may be withheld until the crop is 3 or 4 inches high, when it may be evenly scattered near the plants. It is unnecessary to cover this, though it may prove more promptly effective in absence of rain if cultivated in.

The quantities recommended are in most cases moderate. On soils of good physical character it will often prove profitable to use about one and one-half times the amounts given.

—THE EDITOR.

PERSIMMONS.

The native persimmon (*Diospyros virginiana*), according to a bulletin of the Indiana Station, is "one of our neglected wild fruits which has heretofore received but little attention from the fruit growers of this country, although it possesses many desirable qualities which, when brought to a higher state of perfection by selection and cross fertilization, will certainly cause it to be more highly appreciated by all lovers of good fruit. The general public is quite ignorant concerning its real merits. The fruit is scarcely known except by those who live in sections of the country where it grows wild, and even in these localities but little attention has been given to its cultivation." Recently, however, considerable interest in the persimmon has been awakened. Reports of studies and experiments with persimmons have been made by both the Indiana and Tennessee experiment stations, and improved native and Japanese varieties are being grown at several other stations. A number of persimmon orchards have also been planted in different parts of the country. The following information regarding persimmons is compiled mainly from bulletins of the Indiana and Tennessee stations.

The persimmon grows wild in nearly all the Southern States and as far north as Rhode Island and the Great Lakes. The trees when grown in the open are usually less than 40 feet in height. In forests, however, they often attain a height of 60 feet or more with a trunk diameter of 2 or 3 feet. They are very long lived. According to the Indiana Station—

The opinion held by some that a male or nonbearing tree is needed to fertilize the blossoms of the fruitful tree is erroneous; both sterile and fertile flowers appear on the fertile tree. Occasionally, however, trees are found which do not bear fertile flowers, and of course are worthless so far as the production of fruit is concerned. These trees, however, produce more honey, or nectar, than the fertile ones, as shown by the much greater number of honeybees which visit these in comparison with the fertile trees.

The fruit in the green or partly ripe state is intensely astringent (puckery) to the taste, but usually loses this property on ripening. It varies in size from one-half inch to 2 inches in diameter, and assumes a variety of forms. Each fruit usually contains from 4 to 8 seeds, though a few varieties are practically seedless and others contain more than 8 seeds. The fruit ripens from August to December. Frost apparently aids in the ripening process of some varieties, but is entirely unnecessary with others, as is proven by the fact that many varieties ripen their fruit in August and September, long before the appearance of frost.

Varieties are not true to seed, and vary as much in this respect as does the apple. Persimmons are usually propagated from seed, the seedlings being budded or grafted with improved varieties. Seed for this purpose is gathered in the fall, treated like peach pits during the winter, and planted in the early spring. The seedlings are allowed to remain in the nursery two years and are budded or crown grafted in the spring. Fall budding and midwinter root grafting have both proved unsuccessful at the Indiana Station. Both cleft and whip grafting are practiced, care being taken to cover the cut portion well with grafting wax.

Native seedlings require considerable time before they come into bearing, but when grafted or budded with improved varieties and well cared for they often produce fruit in three or four years from the graft.

Transplanting is best done in autumn. This gives the trees an opportunity to adjust themselves to their new position and the pruned roots time to callous before growth commences in the spring. The long taproot, which is characteristic of persimmons, renders transplanting somewhat difficult. Trees which have been removed once or twice in the nursery, or young trees not more than one or two years from the graft, more readily adapt themselves to this purpose. Ground intended for new orchards should be thoroughly subsoiled to a depth of about 8 inches below the roots of the young trees and kept well cultivated throughout the first seasons.

Persimmons do well on almost any soil, from worn-out red clays to the most fertile bottom lands. A light, well-drained soil is considered

best, however, with a location similar to that demanded by the peach or plum. Response to fertilizers and cultivation is as prompt with persimmons as with other orchard fruits. Valuable orchards can often be quickly grown by top working old native trees with improved varieties. For this purpose, the scions should be inserted in vigorous growing wood. When such wood is not available, some of the branches may be cut off and one of the thriftiest sprouts arising from each stub grafted the following season, the remaining sprouts being removed. It is claimed that the persimmon is as easily grafted as the apple. It does not require much pruning.

It is believed that with proper methods of propagation and cultivation the native persimmon is capable of being improved to such an extent as to make it of the highest commercial importance, equal to that of some of the Japanese varieties. Quite a number of valuable native varieties have already arisen, and these have been named and described. Some of the more important of these are Kemper, Daniel Boone, Shoto, Early Bearing, Hicks, Smeech, Kansas, Golden Gem, Early Golden, and Marion.

The Tennessee Station considers that "a seedless variety, comparatively free from astringency, as large as some of the Japanese class and ripening before the advent of frost in most sections of the South, would be one of the most valuable fruits that have ever been introduced." It is stated that an improved native tree will yield on an average 2 to 3 bushels of fruit, which will bring a good price in the larger cities if of good quality.

The Japanese persimmon (*Diospyros kaki*) has been grown in this country since about 1875. The trees are smaller than those of American varieties and the fruit somewhat larger. The same variations in form, quality, ripening period, number of seeds, etc., which characterize American varieties are also found in the Japanese, and the same methods employed in the propagation of one may be used with the other. Japanese scions are generally used on American stocks.

Some of the larger orchards of Japanese varieties are reported from Florida, Texas, and California; but they are also being successfully grown as far north as Tennessee. Considerable damage to the fruit has been reported by the Florida and Louisiana stations by the attacks of birds, insects, etc., although as a rule the persimmon is unusually free from insect and fungus diseases. Many trees, however, are killed by overbearing.

Japanese persimmons are heavier than American sorts, the average weight of individual specimens being about 6 ounces. The skin is generally smooth with slightly rusty specks, and the blossom end marked by a network of dark lines. The color varies from light yellow to dark red and the flesh varies as much as the skin. Dark-fleshed varieties are usually less astringent and more solid when ripe than light-fleshed varieties. Some of the best varieties are Costata, Hachiya, Hiyakume,

Tsuru, Tane-Nashi, Yemon, and Zenji. A cross section of one of these varieties is shown in comparison with an improved native variety in fig. 1.

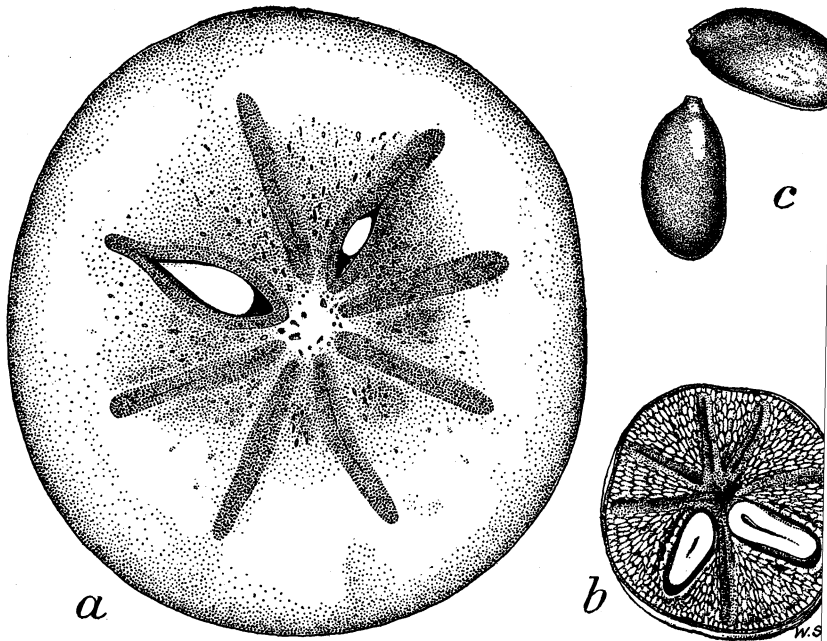


FIG. 1.—Cross sections of Japanese and native varieties of persimmons: *a*, Japanese (Hachiya) natural size; *b*, native (Golden Gem) natural size; *c*, seeds of Golden Gem, natural size.

Analyses of the persimmon have been made by the Indiana, Tennessee, and California stations. The average composition of this and some other fruits is shown in the following table:

Composition of persimmons and other fruits.

	Water.	Protein.	Albuminoids.	Fat.	Carbohydrates.	Fiber.	Ash.	Sugar.	Acid.
Persimmon pulp:	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Native wild	63.04	0.80	0.81	0.35	31.85	1.46	0.92	20.00	.....
Native improved	65.86	.66	.48	.16	31.33	1.26	.73	.....	.....
Japanese	73.33	.73	.....	25.19	.....	.....	.74	16.57	.....
Unknown variety	66.1	.8	.....	.7	29.7	1.8	.9	.....	.....
Persimmon seed, native wild	9.86	10.60	8.10	17.60	56.83	17.60	2.07	.....	.....
Apples	84.6	.4	.....	.5	13.0	1.2	.3	12.4	.....
Cherries	80.9	1.0	.....	.8	16.5	.2	.6	11.0	.....
Oranges	86.9	.8	.....	.2	11.6	.....	.5	9.0	.....
Strawberries	90.4	1.0	.....	.6	6.0	1.4	.6	5.5	.....

It will be noticed that the persimmon contains less water and is richer in the more valuable food constituents than the other fruits included in the table. It is especially rich in sugar, the native fruit containing from 7 to 14 per cent more sugar than the other fruits.

ct, the persimmon is perhaps the sweetest of our common fruits. The native varieties are sweeter than the foreign.¹

The analyses given in the table are of the edible portion or pulp. The percentage of seeds in the fruit was found to vary from 11.5 in an improved native variety to 13.85–18 per cent in wild varieties.

The draft of the persimmon crop on the fertility of the soil is indicated in the following table:

Fertilizing constituents in persimmons and other fruits.

	Water.	Potash.	Phosphoric acid.	Lime.	Nitrogen.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Persimmons.....	61.7	0.39	0.08	0.04	0.40
Apples.....	85.3	.19	.01	.....	.13
Strawberries.....	86.1	.20	.06	.....	.18
Raspberries.....	86.5	.35	.07	.....	.16
Blackberries.....	90.8	.30	.11	.....	.15

The table shows that the persimmon is quite rich in fertilizing constituents and makes a somewhat greater draft upon the fertility of the soil than others of our common fruits. The deep rooting habits of the persimmon probably account for the fact that it often thrives well on comparatively poor soils. Nevertheless the best results will undoubtedly be obtained on such soils only with judicious cultivation and fertilizing, especially with potash and phosphoric acid. Nitrogenous fertilizers should be used with caution. Their excessive use may cause the fruit to drop prematurely.

Persimmons are usually consumed in the fresh state. They keep well, however, and when stored in a cool place can be made to preserve their freshness for weeks. They may be preserved by packing with sugar in a tight jar, and some varieties readily adapt themselves to canning. They may also be canned by simply placing the clean, ripe fruit in a glass jar and pouring over it a sirup made of granulated sugar and water. It is not necessary to heat the fruit before canning. They may be used as occasion demands for making puddings, etc.

“The question of profitableness depends largely upon the demand, and it rests with the grower to a very great extent to create this demand. To create a demand for large quantities it is absolutely essential that nothing but the choicest varieties be placed upon the market, and these in an attractive form.”—C. B. SMITH and THE EDITOR.

FORCING RHUBARB.

Salad plants, tomatoes, muskmelons, green corn, beans, and the like have of late years been added one after another to the greenhouse crops, and the enlarged table menu resulting therefrom has gratified

¹For a brief discussion of the food value of fruits, see U. S. Dept. Agr., Farmers' Bulletin 105 (Experiment Station Work—XII), p. 22.

the epicure and been a source of revenue to the producers. The forcing-house gardener and the city community rather than the farmer have reaped the benefit of these winter creations. The farmhouse kitchen seldom has a greenhouse attachment. It usually has a cellar, however, and it was mainly to show what might be produced in this cellar during the winter as well as in the greenhouse that experiments were recently made at the Rhode Island Station with rhubarb.

Rhubarb plants were dug in December before the ground had frozen and placed in the greenhouse—some in practically full sunlight, others in a warm place under the greenhouse bench, with the sides and ends closed to keep out the light. At the same time other plants were dug and left on the ground—some eleven days, others thirty-four days—and subjected to repeated freezing, thawing, rain, and snow. The plants from the last two lots were taken to the greenhouse and placed beside those already there, and part of those which had been exposed to the weather for thirty-four days were planted in one corner of a dwelling-house cellar and kept screened from the light. The cellar had an average temperature of about 40° F. and the soil was wet and muddy.

About one month after the plants brought into the greenhouse without freezing were put in position they were examined. But little growth had been made. Those in sunlight had remained practically dormant, and when they were removed from the bench two months later the average growth made was only about five-eighths ounce per plant. The plants grown in darkness and harvested at the same time averaged 1.8 pounds per plant. The frozen roots which had been brought in eleven days later than those mentioned above and placed in position with them were examined at the same time. These roots were making rapid growth, especially those in the dark, where many vigorous stalks had started, some of which had attained a length of from 12 to 20 inches. Of this growth the most was stalk, but little leaf being developed. The product from these stalks was delicately colored and of good flavor. These plants gave a total average yield of 4.6 pounds per plant for roots grown in the light and 6.2 pounds per plant for roots grown in darkness.

It seemed probable that the plants which had been dug and left lying on the ground for thirty-four days, exposed to all sorts of weather, would be much weakened thereby. They were examined ten days after being brought in. The plants under the greenhouse bench had started into good growth. Many stalks were 3 or 4 inches long. Three weeks from the date of planting they yielded 1 pound of stalk per plant, and a final total harvest of 5.17 pounds per plant. The best total yield of the different lots, however, was obtained from the roots placed in the dwelling-house cellar. The development of these plants was slow. They had just started into growth three weeks after being brought in, and gave their first product nearly nine weeks from date of planting. They continued to produce for two months and when finally

removed from the cellar had given an average yield of 13.4 pounds per plant, or more than double the yield obtained from any of the other lots. (See fig. 2.)

The cooking qualities of the plants grown in darkness and in light were tested. Sauce made from stalks grown in the light was less attractive in appearance than sauce made from stalks grown in darkness. Its flavor, however, was more pronounced. The attractiveness of the sauce seems to depend upon the method of cooking and the color of the stalk, while the color of the stalk is influenced by conditions under which it grows. Thus, stalks grown in darkness were more delicately colored than stalks grown in the light, and "that taken from the cooler dwelling-house cellar was much brighter and more highly colored than that grown in the warmer position beneath the greenhouse

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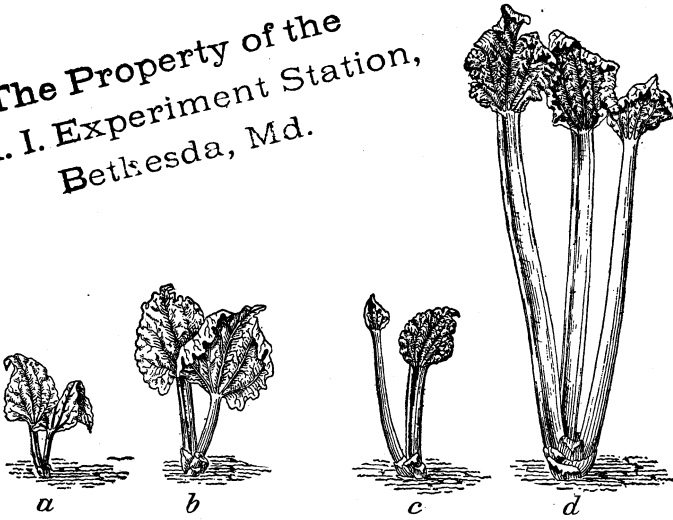


FIG. 2.—Forcing rhubarb: *a*, unfrozen, grown in the light; *b*, frozen, grown in the light; *c*, unfrozen, grown in darkness; *d*, frozen, grown in darkness.

bench." Hot water immediately applied to the stalks seemed to extract much of the color. Sugar should be added to the sauce after it has cooked rather than before, as otherwise "the acid present in the rhubarb acts upon the sugar, changing it into glucose,¹ and the higher the temperature the more rapidly does this change go on."

In these experiments plants grown in light developed much more leaf and grew much more slowly than plants grown in darkness, and freezing the roots had a marked beneficial influence on rapidity of growth and total yield of product. The work seems to show that if rhubarb plants are frozen and then planted in mellow earth in a frost-proof cellar a product can be secured in February or March rivaling in texture, color, and quality that usually secured from the open field from six weeks to two months later.—C. B. SMITH.

¹ Glucose has less sweetening power than ordinary or cane sugar.

EAR CORN VERSUS CORN-AND-COB MEAL FOR COWS.

The New Jersey Station has made experiments to determine whether it is more economical to grind corn (kernels and cobs together) for milch cows than to feed the ear corn without grinding. In these experiments one cow was fed for twelve days ear corn which had been run through a fodder cutter and another the whole ears finely ground (corn-and-cob meal). After a transition period of five days the feeding was reversed; i. e., for twelve more days the cow which had previously been fed ear corn was given corn-and-cob meal, while the other which had previously received corn-and-cob meal was given ear corn.

The yield of milk on the corn-and-cob meal ration was 45.2 pounds, or 9.3 per cent greater than with the ear-corn ration, and the yield of butter fat in the milk was 1.9 pounds, or 4.9 per cent greater. The cows also gained slightly in weight on the corn-and-cob meal. "As the two rations were alike in amount and in composition and the lactation periods equalized, it is believed that the increase in yield from the corn-and-cob meal ration over the ear-corn ration was due to its greater digestibility." An examination of the droppings from the cows showed that 57.3 per cent of the corn fed on the ear passed through the animal undigested.

In the experiments just described, 144 pounds of corn-and-cob meal gave an increase of 45 pounds of milk over the same amount of ear corn, which, at $1\frac{1}{2}$ cents per pound, would have amounted to 67.5 cents. On this basis the feeding value of 1 ton of corn-and-cob meal would be \$9.38 more than 1 ton of ear corn. Assuming that only 1 cent per pound could have been secured, which is probably nearer the actual price received by many farmers, the feeding value of a ton of corn-and-cob meal would be \$6.25 more than a ton of ear corn. Deducting the additional cost of husking and grinding a ton of ear corn, which is estimated at \$4.25, we have a difference, on the basis of $1\frac{1}{2}$ cents per pound for milk, of \$5.13, and on the basis of 1 cent per pound, of \$2, which represents the increase in value of a ton of ear corn when fed in the form of meal rather than whole.

—THE EDITOR.

WASTE IN FEEDING CORNSTALKS.

"With many farmers cornstalks form a large part of the roughage fed to their stock during the winter, and the greater portion of the stalk below the ear is wasted." In an experiment at the New Jersey Station it was found that of 200 pounds of stalks fed to a cow during ten days 60 pounds, or 30 per cent, remained uneaten. The composition of the stalks and of the waste is shown in the following table:

Composition of cornstalks and of uneaten portion of stalks (waste).

	Water.	Fat.	Fiber.	Albumi- noids.	Protein.	Ash.	Nitrogen- free ex- tract.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Cornstalks (original).....	15.06	1.29	27.18	3.98	4.07	4.86	47.54
Waste (uneaten portion).....	15.58	1.34	34.20	2.17	2.43	3.05	43.40

The most striking difference in the composition of the cornstalks and waste is found in the fiber and protein, the former being over 7 per cent greater in the waste and the latter 1.64 per cent greater in the stalks. It will also be noticed that a much larger percentage of the protein in the stalks is in the form of albuminoids.

The waste is thus much poorer in food constituents than the stalks, and is doubtless less digestible than the part consumed, but still possesses considerable value for feeding purposes, provided it can be rendered palatable to the animal.

Shredding would no doubt result in more complete consumption of the stalks, and, according to the New Jersey Station, "at least five-sixths of the 30 per cent waste in feeding dried cornstalks, as indicated in the experiment, could be prevented by using a well-built silo; besides, 12 per cent more milk could be produced from the silage than from the dried stalks."—THE EDITOR.

MOLASSES AS A FOOD FOR FARM ANIMALS.

A number of years ago the value of molasses as a feeding stuff for farm animals was studied at several of the stations. It is a common practice to feed molasses to stock in regions where sugar is manufactured. The molasses is usually mixed with some other material which absorbs it so that it may be readily handled. At the Texas Station molasses was advantageously introduced into a ration of cotton-seed meal and cotton-seed hulls for cattle. The use of half a pint of molasses for each daily ration resulted in the profitable consumption of a larger amount of food by cattle. It did not improve a ration consisting largely of silage.

The Maryland Station reported a fattening experiment with steers in which molasses was added to a ration consisting of corn meal, cotton-seed meal, hay, and rye straw. No conclusions were drawn as to the effect of molasses, although the test as a whole gave satisfactory results.

Many of the stations have analyzed molasses in connection with sugar-beet or sugar-cane investigations, or with a view to determine the presence of adulterants.

Within the last few years much attention has been given to the value of molasses as a feeding stuff by foreign stations. In view of the efforts to extend the manufacture of beet sugar in the United States these experiments are interesting, since the profitable utilization of by-products is a matter of great importance.

Cane-sugar molasses obtained under average conditions which prevailed in this country a few years ago had approximately the following composition: Water, ash, and organic matter other than sugar, 49.4 per cent; cane sugar, 30 per cent; reducing sugar, 23 per cent. The molasses produced to-day at a well-equipped small factory, working economically, contains on an average 20 per cent cane sugar and 20.5 per cent reducing sugar. That made at the best of the large central establishments contains approximately 20 per cent cane sugar and 25 per cent reducing sugar (glucose). The percentage composition of beet molasses is, approximately, water, 20.5; organic matter other than sugar, 22; cane sugar, 47.5; reducing sugar, 5; ash, 9.5. It will be noticed that the cane-sugar molasses contains much more reducing sugar than that obtained from sugar beets. The cane sugar and reducing

sugar together make up a large part of the material commonly called nitrogen-free extract (carbohydrates) in food analyses. The reducing sugars have less sweetening power than cane sugar.

A study of the composition of molasses shows that it contains a large amount of nitrogen-free extract (carbohydrates). The crude product contains considerable nitrogenous material, although it does not follow that this consists of the highly nutritious albuminoids. In the following table the composition of beet-sugar molasses is compared with that of a number of common feeding stuffs. The analysis of molasses is quoted from a report of the Canadian Experimental Farms:

Composition of molasses and other feeding stuffs.

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Beet-sugar molasses	25.7	7.3	-----	^a 58.2	-----	8.8
Green corn fodder	79.3	1.8	0.5	12.2	5.0	1.2
Timothy hay	14.1	5.0	2.2	43.7	31.1	3.9
Corn silage	79.1	1.7	.8	11.0	6.0	1.4
Sugar beets	86.5	1.8	.1	9.8	.9	.9
Corn	10.9	10.5	5.4	69.6	2.1	1.5

^a Made up of 50.2 cane sugar, 3.5 reducing sugar, and 4.5 per cent undetermined.

It will be seen that molasses is a bulky food; that is, it contains a considerable amount of water in proportion to the total nutrients. It is lacking in fiber. The carbohydrates (nitrogen-free extract) constitute the most important group of nutrients in the molasses; that is, it is a feeding stuff which must be supplemented by some material rich in protein.

As pointed out in the Canadian Experimental Farms Reports, one-half of the ash of beet-sugar molasses is potash.

It is the presence of this, no doubt, that is the cause of the looseness of the bowels of cattle fed above a certain quantity per diem. When symptoms of this condition are observed, the quantity of molasses fed should be reduced. Since potash is not retained by the animal, but is eliminated by the kidneys, the urine will be especially rich in this element, and therefore should be carefully preserved by the use of absorbent bedding.

In Europe a number of "molasses feeds" have been proposed. One of these, which has been used to a considerable extent, is made up of bran 4 parts, molasses 3 parts, and palm-nut cake 1 part. Molasses is also mixed with dried blood, with peat, and with extracted beet pulp. The latter mixture is dried, and possesses good keeping qualities.

In a number of European experiments reported molasses feeds were tested with dairy cows. No deleterious results were noticed, even when 4 to 5 pounds of molasses was fed daily. An extended study of the value of molasses as part of a ration for pigs, steers, sheep, milch cows, and horses was recently reported in a French agricultural journal. The principal conclusions from the investigation were as follows: When molasses formed part of the ration of sheep, pigs, and steers, the gains

in live weight were rapid. When molasses was fed to milch cows the total milk yield and the amount of fat and milk sugar in the milk was increased. The increase is not regarded as sufficient to warrant the conclusion that molasses is a suitable food for milch cows. Molasses is regarded as an excellent food for horses. It was readily eaten, and vigor and weight were maintained when it was added to the ration. Molasses may be advantageously employed for rendering inferior hay or fodder more palatable.

The report of the Canadian Experimental Farms already referred to notes briefly the successful use of molasses in fattening steers. Three to 5 pounds was fed per day, diluted somewhat, and poured over the cut coarse fodder. It is said the steers developed a great liking for it, and to all appearances it gave good results. The test was summed up as follows:

The most important points in favor of this new feeding stuff may be stated as follows: (1) It contains a large percentage of sugar, the most assimilable form of carbohydrates found in cattle feeds. This class of nutrients is used by the animal for the production of energy, the maintenance of the vital heat, and the production of fat; (2) it stimulates the appetite, and (3) probably increases the digestibility of the other constituents of the ration.

In the experiments cited above beet-sugar molasses was fed. An interesting experiment in which cane-sugar molasses was added to the ration of horses was recently reported in an Australian journal. At the Rarawah sugar plantation in the Fiji Islands over 400 horses were satisfactorily fed a ration containing a considerable amount of molasses, as much as 30 pounds per head daily being fed at different times. The ration finally adopted consisted of 15 pounds of molasses, 3 pounds of bran, and 4 pounds of maize per head daily. In addition, green cane tops were fed. The health of the horses remained excellent. Molasses did not cause diarrhea, but rather constipation, which was counteracted by the bran fed. Feeding molasses effected a saving of over \$45 per head per annum. Such a saving was, however, believed to be possible only by reason of the large quantities of waste molasses and valueless cane tops available on the spot. The experiment was continued for a considerable time. Some of the conclusions drawn were as follows:

For working horses the sugar in cane molasses is a satisfactory substitute for starchy food, being readily digested and transformed into work. Fifteen pounds of the molasses can be given to a 1,270-pound working horse with advantage to the health of the animal and to the efficiency of its work. It produces no undue fattening, softness, or injury to the wind. The high proportion of salts in it has no injurious effect. An albuminoid ratio as low as 1:11.8 has proved highly suitable for heavy continuous work when a sufficient quantity of digestible matter is given.

These are only a few of the tests which might be cited. It is not the purpose of this article to recommend that molasses be generally adopted as a feeding stuff, but rather to call the attention of those who are interested to the subject so that tests may be undertaken or experience already gained may be reported.—C. F. LANGWORTHY.

RECENT EXPERIMENTS IN FEEDING DUCKS.

The feeding and management of poultry has been studied by a number of the stations. In most cases the work has been confined to chickens, although some noteworthy investigations have been conducted with geese.¹ Quite recently three of the stations have reported experiments with ducks.

The Michigan Station studied the comparative growth made by 39 young ducks and the same number of chickens on similar rations. The ducks were two weeks old at the beginning of the test and were fed middlings, corn, and bran, together with the necessary grit and green food (lettuce), and were given the run of a small yard with a grass patch. The chickens were fed bran and relatively more corn meal than the ducks, but had no middlings. They were also given lettuce and allowed the run of a grass plat. Both chickens and ducks were given skim milk in addition to the other food. At the beginning of the test the ducks weighed 13.25 pounds and the chickens 7.5 pounds. In five weeks the ducks were nearly ready for the early market and had gained 108.75 pounds. They had eaten 41.3 pounds of corn, 93.1 pounds of middlings, 43.4 pounds of bran, 59 pounds of lettuce, and 88 pounds of skim milk. The total cost of a pound of gain was 1.9 cents. In the same period the chickens had gained 30 pounds and had consumed 52.2 pounds of corn, 25.9 pounds of bran, 46 pounds of lettuce, and 44.3 pounds of skim milk. The total cost of a pound of gain was 4.84 cents. In discussing the profits corn and bran are rated at \$14 and middlings at \$15 per ton, milk at 20 cents per hundred, and lettuce at 1 cent per pound. The ducks gained much more rapidly than the chickens and the gains were more economically made. The chickens were not large enough for market at the close of the test and the feeding was continued for some time before they were sold.

At the North Carolina Station 18 Pekin ducks were fed for fifty-six days from the time they were hatched. At the beginning of the test the total food consisted of 4.4 ounces of corn meal and an equal amount of bran per head daily, while at the close of the test, 6 pounds 10 ounces of meal, 4 pounds 3 ounces of bran, and 3 pounds 5 ounces of bone were fed daily. In addition to the grain an amount of fine grit equal to one-sixth of the weight of the grain, and chopped green clover equal to one-fourth the bulk of the ration were also fed. All the feed was mixed with water to a crumbly mass and fed in troughs. No water was allowed except for drinking purposes. In this test corn meal, cut bone, and grit were each rated at 1 cent per pound and wheat bran at 0.9 cent per pound. Account was also taken of the value of the clover fed, the eggs set, and the food of hens carrying the ducks. The ducks weighed 2 ounces when hatched, and 4 pounds 15½ ounces at the close of the test. The cost of a pound of gain was 5.05 cents; that is, the

¹ See U. S. Dept. Agr., Farmers' Bul. 65 (Experiment Station Work—II), p. 12.

ducks cost on an average 25 cents to fatten and were sold for 50 cents each.

Experiments at the New York State Station already noted in this series of bulletins¹ showed that ducks did not thrive and make rapid growth unless they were fed a considerable amount of animal matter, the most rapid and economical gains being made when from 40 to 50 per cent of the protein of the ration was supplied in the form of animal matter.

The above experiments were made for different purposes, but the inference may be fairly drawn from all that ducks can be profitably fattened under proper conditions. The standard breeds of ducks have been described, and the feeding, management, and marketing of ducks discussed at length in a recent bulletin of this Department.²—C. F. LANGWORTHY.

THE COST OF RAISING CALVES.

The New Hampshire Station has attempted to determine the average cost of raising a dairy cow. For a considerable period records were kept of the food consumed and the cost of the gains made by 13 heifer calves from the time they were weaned until 16 months old. The calves were taken from the cows as soon as the latter's milk was fit for creamery use and were fed whole milk. This was gradually replaced by skim milk, until by the end of the second week only separator milk, which was almost free from fat, was fed. To replace the fat, ground flaxseed, cooked to a jelly in water (1 pound of flaxseed to 4 quarts of water), was added to the milk. Seven to 10 quarts of skim milk and 1 or 2 quarts of the flaxseed mixture were fed daily per head in two feeds. During part of the time middlings was substituted for flaxseed. As soon as possible the animals were encouraged to eat grain and hay. The amount of these feeding stuffs was increased as the animals increased in size and weight, while the skim milk and flaxseed remained nearly constant until they were discontinued, when the calves were 6 to 8 months old and were turned out to pasture. Some of the calves were taught to drink from a pail, but most of them were fed by means of a "calf feeder," which greatly lessened the work of feeding. A careful watch was maintained to note any indigestion. Diarrhea or scouring was quickly stopped by reducing the amount of food and adding limewater to the milk.

In discussing the cost of the gains made the different feeding stuffs are rated per hundred pounds, as follows: Milk, \$1; skim milk, 20 cents; flaxseed, \$3.25; middlings, 80 cents; bran, 70 cents; linseed meal, \$1.25; oats, \$1; oatena, 65 cents; mixed grain (middlings, oat feed, and linseed meal 2 : 2 : 1), 90 cents; hay, 50 cents, and green bar-

¹ U. S. Dept. Agr., Farmers' Bul. 97 (Experiment Station Work—X), p. 16.

² U. S. Dept. Agr., Farmers' Bul. 64 (Ducks and Geese. Standard Breeds and Management.)

ley fodder, 15 cents. It is stated that little difficulty was experienced in keeping up a steady growth in size and gain in weight. Differences were always noticeable between individual animals in the rate of growth and amount of food consumed. Large animals invariably required more food to maintain their condition than small ones.

It was found that 8 calves under 5 weeks old made an average weekly gain of 7.6 pounds, at a cost of 40.6 cents; from 5 to 9 weeks the average weekly gain was 9.1 pounds and the cost 36.7 cents. The same number of calves from 9 to 13 weeks old made an average weekly gain of 11.8 pounds, at an average cost of 43.1 cents. Eight calves from 13 to 20 weeks old gained per week on an average 10 pounds, at a cost of 52.9 cents; 6 calves from 4 to 8 months old made an average weekly gain of 11.1 pounds, at a cost of 63.7 cents; 2 calves from 8 to 13 months old made an average weekly gain of 5.25 pounds, at a cost of 58.3 cents; 4 heifers 13 to 16 months old made an average weekly gain of 6.12 pounds, at a cost of 65.1 cents per week; 4 of the heifers were maintained on pasture from July 24 to October 26, 1897, and the total gain in weight of the 4 animals was 313 pounds.

During the feeding periods * * * comparisons were made between cooked ground flaxseed and cooked middlings as a substitute for the fat in milk, and also between rations including the cooked food and those without it.

[In one trial] the calves were between 5 and 8 months old, and the middlings proved to be a satisfactory substitute for the ground flaxseed, the cost being less and the gain in weight large enough for the purpose, though a little smaller than on the flaxseed.

The calves [in another trial] were also over 5 months old. The substitution of the dry grain lessened the cost, and the gain was sufficiently large, although smaller than in the previous period.

These trials show that for calves at the age of those described there is no object in using anything but dry grain and hay along with the skim milk, unless the greatest possible amount of growth is desired.

[The cost of rearing a calf dropped October 1 is calculated as follows:] For five months, or twenty-one and two-thirds weeks, the cost, according to our own data, would be 44.2 cents per week, or \$9.57. For the next three months, or thirteen weeks, our data would make the cost 63.7 cents per week, or \$8.28.

The pasture season would now be at hand and continue for five months, and the cost would vary with the location. The figures that we have obtained for calves range between \$1.50 and \$2.50 for the season.

The remaining three months would cost, according to our data, 65.1 cents per week, or \$8.46 for the thirteen weeks. The total cost for the food consumed by the heifer during the sixteen months would then be \$28.81, and she would weigh from 600 to 700 pounds. * * *

The heifers were fed much more freely with hay than was necessary, which was due to the abundant crop of the year. Were the schedule price of hay in this particular case assumed to be the actual price of hay in the mow at the time of feeding, the average cost per week would be much reduced.

In conclusion, * * * high-priced foods, viz, whole milk, flaxseed, linseed meal, and oats, will cause the cost of the weekly ration to increase out of proportion to the gain, if fed freely. Flaxseed can not be used with economy except in the earliest stages of growth (the first two or three months), and whole milk should be discontinued as soon as possible.

—C. F. LANGWORTHY.

FEEDING CALVES WITH THE MILK OF TUBERCULOUS COWS.

Experiments were recently made at the Connecticut Storrs Station for the purpose of determining to what extent the milk of tuberculous cows is dangerous for feeding calves. Four Devon cows which were judged to be in the earlier stages of tuberculosis were chosen for the experiment. The four cows in question had been tested in March, 1896, with tuberculin without giving any response. In October of the same year the four cows just referred to responded to the test and were selected for experiment. The fact that the cows did not respond to the test in March was taken as evidence that the disease could not have existed any great length of time. It was proposed to study the effect of milk from cows in the first stages of tuberculosis, when fed to healthy calves, and also the danger of transmission of the disease by close proximity to diseased animals. The cows were placed in a light, airy stable which afforded about 1,500 cubic feet of space per cow. The cows were tested again in January, 1897, with the result that all four of them responded definitely to the test. In April of the same year another test was given to the cows, and at this time only two of them responded, while the other two showed no reaction to the tuberculin. In July of the same year another test was made, at which time none of the cows showed any rise of temperature or other physical signs which would indicate the presence of tuberculosis. The college veterinarian, in making a report upon the condition of the four cows February 7, 1899, found that one cow had a slight but chronic tendency toward diarrhea; that one would be condemned as tuberculous upon a physical examination; and that the other two were apparently in excellent physical condition, and no cough had been observed in any of the cows.

The milk of these four cows during a period of over two years was fed to calves from healthy cows, and also in some cases to their own calves. In some cases the calves were allowed to suck the cows and were also fed with milk from a pail. During the first eighteen months the calves were stabled together with the cows. During the experiment eight calves were fed with tuberculous milk. Only one of this number contracted the disease, and this case appeared six months after the feeding experiment with milk had closed and after the animal had been exposed for some time to contagion by other means. It was shown to be possible that contagion by saliva took place in this case. When the animal had been killed, the only trace of tuberculosis which was found consisted of a few small tubercles in one of the pharyngeal glands of the throat. One of the calves used in the experiment came from a cow which had been tested and was supposed to be free from tuberculosis but which shortly after the birth of the calf developed a severe case of tuberculosis. This calf was fed milk from one of the experiment cows and developed into a strong and vigorous animal. All the calves upon which experiments were made in feeding milk from tuberculous cows were frequently tested with tuberculin, but, as just indicated, with a

single exception none of them responded. The experiments under discussion tend to show that the danger from the milk of tuberculous cows has been somewhat overestimated and is not as great as is usually supposed. The number of cows and of calves which were used in this experiment was small. The results, however, were very uniform and can scarcely be interpreted as indicating that the one calf which afterwards contracted the disease was infected through the milk. The calves were fed with the milk of the tuberculous cows for periods varying from three to sixteen months. The experiments were confined to cows which at the beginning of the test could not have been condemned as tuberculous from a physical examination. The disease was therefore in the incipient stage and had not affected the udder in any case even at the end of the period of experimentation; in fact, no glands of the body were found to be affected. The conclusions to be drawn from these experiments should therefore be limited in their application to cows which respond to the tuberculin test but which are in the earlier stages of the disease. The results agree with the majority of European investigations along the same lines, but can not be applied to cases where the disease has progressed far enough to cause an affection of the udder.—
E. V. WILCOX.

KILLING THE GERMS OF TUBERCULOSIS IN MILK.

The pasteurization of milk has been effected by different experimenters with temperatures ranging from 140° to 212° F. When high temperatures were applied the purpose was to destroy all the bacteria found in milk without regard to whether the milk was cooked during the process or not. Pasteurization at low temperatures was not considered as rendering the milk perfectly sterile, but only as destroying the majority of the germs and thereby rendering the milk relatively harmless.

Experimenters differ to some extent in opinion as to the exact amount of heat required to destroy the bacillus of tuberculosis, and it is conceded that the bacillus possesses varying powers of resistance under different circumstances and in different stages of growth, so that a temperature which would be effective in destroying the organism in one stage would be ineffective at another.

In some experiments recently conducted at the Michigan Experiment Station the pasteurization of milk was carried on under uniform conditions. The milk was kept for twenty minutes at a temperature of 155° F. In order to be absolutely certain that the milk contained the tubercle bacilli in a tolerably constant proportion, the milk was first sterilized and allowed to cool, and then tuberculous material was added to it and the whole thoroughly stirred. The tuberculous material for each experiment was taken from a different source, the object of this being to determine the variation in resisting power of tubercle bacilli of different origins. All the material was taken from organs of cows

in an advanced stage of tuberculosis. In every case, after the milk had been heated, a small quantity of it was inoculated into guinea pigs to determine definitely the completeness of sterilization. No case of tuberculosis developed from these inoculations. Guinea pigs which were inoculated with samples of the same milk before treatment developed in every case acute tuberculosis. The experiments conducted at the Michigan Station did not have in view the determination of the effectiveness of temperatures below 155° F. in the destruction of the tubercle bacillus. It was found, however, that exposing milk for ten minutes to a temperature of 140° F. would not destroy the bacillus. Pasteurization at a temperature of 155° F. does not affect the taste of the milk, and when carefully done is apparently quite effective in destroying the tubercle bacillus. In many dairies, however, pasteurization is carelessly performed and is not effective in destroying all of the tubercle bacilli.

The experiments under discussion developed the fact that it is necessary in pasteurizing milk to take great precaution in order to be certain that all the milk reaches the required temperature. When milk is placed in vessels which are partly immersed in water and the water heated, it is not sufficient simply to heat the water to the required temperature and then remove the source of heat; nor is effective pasteurization secured by applying heat until the milk has reached the right temperature and then removing the heat. In one case it was found that when a bottle of milk was placed in a vessel of water so that the height of the water equaled that of the milk it required twenty-four minutes to raise the temperature of the water to 155° F., and twenty-nine minutes to raise the milk to the same temperature. In this experiment there was found to be a difference in the temperature between the bottom and surface of the water of 5° and between the bottom and surface of the milk of 2 or 3°.

Therefore: (1) "Any method which is controlled entirely by the temperature of the water is unreliable. (2) Any method which allows the water and milk to stand for twenty minutes when the water has reached 155° F. without further application of heat is variable and uncertain. (3) The temperature of the water is no indication of the temperature of the milk, and the only way safety can be guaranteed by the temperature of the water is to heat the water to a sufficiently high degree to render the temperature of the milk safe beyond doubt. (4) There is much variation in the temperature of unstirred water or milk. Milk should be stirred when pasteurized at 155° F."

As stated above, milk exposed to a temperature of 140° F. for ten minutes is not sterile. The experiments recorded show that milk kept for twenty minutes at a temperature of 155° F. is thereby rendered sterile. The range of 15° F. seems rather small, and it would appear that occasionally the tubercle bacilli in an unusually resistant condition might survive pasteurization even at the higher temperature. It seems

therefore advisable that a still higher temperature should be used during pasteurization provided objection is not taken to the changed flavor of the milk produced by the higher temperatures. A cooked flavor and odor are imparted to milk when exposed to temperatures above 158° F. Certain well-known changes take place in the milk when heated to this temperature, and as a result the milk is found to be less easily digested by some children. If, however, the milk is readily digested after undergoing this change and no objection is raised on account of its taste, it would seem to be both simpler and safer to use the higher temperature. In this case pasteurization would be complete, and could be accomplished without any elaborate apparatus for regulating the temperature.—E. V. WILCOX.

ROPY MILK AND CREAM.

The great importance of thoroughly scalding or otherwise sterilizing all the utensils used in handling and delivering milk is emphasized by



FIG. 3.—Ropy milk.

the investigation of two outbreaks of ropy milk and cream handled by two different dealers made by the New York Cornell Station. The matter became so serious that the dealers were losing their customers and appealed to the station for aid. No complaints were made when the milk was used immediately, but when allowed to stand over night, even at a temperature of 45° to 50° F., the cream on the surface became ropy to such an extent that it would adhere to a table fork, stringing out in a ropy mass. (See fig. 3.)

The ropiness was found to be due to the action of a bacillus which was present in the ropy cream, but the point at which the milk became infected with it was only discovered after considerable investigation. The examination of the milk of different cows as it was drawn from the udder and of the dust and dirt of the stable showed that the milk

was not infected when taken from the bran. In the case of one dealer the night's milk was held over night in deep cans set in cold water, and the morning's milk was aerated and strained in the dairy room. The brass-wire strainer used for straining all of the milk into the deep setting cans proved to be in a filthy condition, owing to lack of thorough cleaning. This strainer was found on two different days to be capable of contaminating milk with the specific organism which caused ropiness. Two out of four deep setting cans examined were in a like condition. In the other case an examination of the milk as drawn from the different cows failed to show any ropiness, and the contamination was traced to the cans used for holding the milk over night or during delivery. The strainer in this case could not be charged with the contamination.

The indications were that in both of the above cases a more thorough scalding of the utensils would bring relief, and it was suggested that the smaller utensils be totally immersed in boiling water for three minutes and the larger cans be filled to the brim with boiling water for a like time. This suggestion was adopted and immediately the trouble disappeared.

Owing to the unusual ability of the bacillus causing ropy milk to grow at a low temperature, keeping milk submerged in ice water or in a refrigerator would not prevent the ropiness, and might even cause this particular bacillus to predominate in the milk over other forms incapable of growing at the low temperature.

It was impossible to determine the original source of infection of the cans, but from the work of others it is believed that it may have been water used for washing the utensils or in which the cows had waded. "Bacteria may readily be transferred from running water to milk by the agency of mud, which, drying upon the udder, may be dislodged during milking. Milk utensils which have been used for containing water should be scalded before using again for milk. The apparent purity of water used about a creamery gives no assurance that it is free from bacteria."

Another important point which was brought out is the injustice which may be done to innocent dealers by the failure of consumers to thoroughly cleanse their milk pails or pitchers. Consumers who had been annoyed by the milk becoming ropy frequently transferred their patronage to another dealer, often without remedying the difficulty, because their own utensils were not thoroughly scalded. The infection was continued through their own milk vessels, and gave rise to the belief that the trouble was more widespread among dairies than was the case.

Once infected, the milk pail or cream pitcher may harbor *Bacillus lactis viscosus* (the bacillus of ropy milk) indefinitely, since thorough scalding is not a prominent feature in kitchen dish washing. Undoubtedly in this and in many other cases of a similar nature, the consumer has unintentionally wrought great injustice upon innocent dealers, by too hastily condemning the milk furnished, when the true cause was careless dish washing. The importance of scalding vessels which have once contained ropy milk or cream can not be too strongly emphasized.

—E. W. ALLEN.

DAIRY SALT.

The Wisconsin Station has recently made a study of various brands of domestic and foreign dairy salt, which is one of the first systematic studies of the kind made by the stations. It is estimated that approximately 82,000,000 pounds of salt, valued at about \$800,000, are used annually in the United States for dairy purposes. Good salt is so important a factor in making good butter and cheese as to entitle the matter to investigation.

Chemically, salt is a compound of chlorin and sodium, known as chlorid of sodium or sodium chlorid. It always contains appreciable quantities of a number of other substances which are present as impurities. These may be in the form of chemical compounds occurring in nature with salt or added during the process of manufacture, as calcium sulphate, calcium chlorid, magnesium chlorid, magnesium sulphate, sodium sulphate, calcium carbonate, and magnesium carbonate; or, in the form of mechanical impurities, as dirt, pan scale, pieces of wood, and the like. Water also constitutes a certain percentage of commercial salt.

In the study at the Wisconsin Station chemical and mechanical analyses were made of 81 samples of dairy salt, 42 of which represented 10 of the leading brands found on the American market. An inspection of the analytical data for these 10 American brands shows a content of pure sodium chlorid ranging from 97.44 to 99.41 per cent. Of the impurities, calcium sulphate was present in quantities ranging from 0.31 to 1.87 per cent; calcium chlorid, 0.02 to 0.65; magnesium chlorid, 0.02 to 0.19; insoluble matter, none to 0.14, and moisture, none to 0.40 per cent. In view of the nature and extent of the investigation, the average of the analyses of the 10 brands may be considered as representing fairly the composition of the best grades of dairy salt in general use in this country. It is as follows: Sodium chlorid, 98.32; calcium sulphate, 1.11; calcium chlorid, 0.27; magnesium chlorid, 0.09; insoluble matter, 0.03, and moisture, 0.18 per cent. As compared with the 25 samples of Canadian and European brands of salt examined, the results show a higher degree of purity, less variation in composition, and uniformly finer grain in favor of the American brands.

The total amount of impurities in the leading domestic brands is seen to range from 0.59 to 2.56, with an average of 1.68 per cent. The percentage, however, is of less real consequence than the character of the foreign substances. Magnesium chlorid is recognized universally as giving a bitter flavor to butter. Calcium chlorid also exerts a similar though less marked influence. These two chlorids tend, probably, to bring about a slow decomposition of the butter fat, which accounts for the unpleasant taste. While, therefore, their presence may not be noticeable in fresh butter, it becomes apparent in butter kept in storage for any length of time, and hence is particularly objectionable in salt used in the manufacture of butter not intended for

immediate consumption. The other chemical compounds offer less serious objection as regards the flavor of butter. The impurities may be such as to render the salt alkaline, in which case decomposition of the butter would be hastened. The mechanical impurities are undesirable for obvious reasons.

One other though less practical objection to the presence of any large amount of calcium and magnesium chlorids in salt is the water-absorbing power of these substances. In an experiment three samples of salt containing, respectively, 0.23, 0.44, and 0.84 per cent chlorids of magnesium and calcium were placed in a damp atmosphere. In twenty-four hours the samples increased in weight 0.02, 0.08, and 0.50 per cent, respectively. At the same time three samples were placed in an atmosphere saturated with moisture. In one hour these increased in weight 0.41, 0.53, and 0.95 per cent, respectively, and in twenty-four hours 4.11, 4.73, and 4.87 per cent. From these results it is apparent that the higher the content of calcium and magnesium chlorids in salt, proportionately greater will be the amount of water absorbed when the salt is exposed to moisture. This necessitates more care in the storage of such salt in order to prevent caking.

In connection with the chemical analyses of the different samples, determinations were made of the size of grain, the apparent specific gravity, and the relative rate of solubility. In the manufacture of both butter and cheese, the size of the salt grain plays an important part. If the salt is very coarse, its even distribution throughout the product is impossible; very fine salt, on the other hand, favors the retention of an undesirable quantity of water. Separating the samples by means of sieves into three portions, designated as coarse, medium, and fine salt, it was found that the butter salts examined were composed mainly of the fine and the cheese salts of the medium grain. Some coarse salt was found in both classes, the proportion, however, being decidedly greater in the case of cheese salt. The fineness or coarseness of salt is also shown by the apparent specific gravity. A fine-grained salt packs more closely and hence a given volume weighs more than the same volume of coarse salt. As shown by the practical tests made, the solubility of salt is also dependent upon the size of grain, a fine salt passing into solution much more readily than a coarse salt.

A comparative test was made of salting butter with fine-grained and coarse-grained salt. The butter from each of twelve churnings was divided into two portions, one of which was salted with fine and the other with coarse salt. The weight of each lot was determined before and after salting and working. Of 1,168 pounds of granular butter salted with coarse-grained salt the loss of weight during the working amounted to 32.65 pounds. Of 1,132.2 pounds salted with fine-grained salt the loss was 51 pounds. As far as weight is concerned, this particular experiment shows a difference in favor of coarse-grained salt of 1.8 per cent, with no marked difference in the flavor of the butter.

Among the requirements of a good dairy salt, according to the Wisconsin Station bulletin on the subject, are a pure white color, neutral reaction, and uniform grain. There should be no offensive odor, and the salt should be practically free from bitter-tasting salts, as magnesium chlorid, and from mechanical impurities. For butter making the grain should be medium in size, and preferably in the form of a thin flake. Of the dairy salts examined at the Wisconsin Station the results show that "no special brand stands first in all respects, but that there is in general a fair choice between several of our leading dairy salts."

The use of salt in butter making is considered as serving three distinct purposes. In the first place it aids in the process of working which has for its object the removal of buttermilk. When salt is added to the butter the small globules of buttermilk tend to collect into larger drops which are more readily worked out. The liquid thus removed from the butter differs from buttermilk in having, in addition to a considerable portion of the salt, no fat and only a small content of protein as compared with that of milk sugar. The extent to which salt is of value in this way is indicated by a comparison of the composition of salted and unsalted butter. In a summary of compiled analyses the average water content of 242 samples of unsalted butter was 1.12 per cent higher than the average water content of 1,676 samples of salted butter. The value of salt as a preservative is another important reason for its use. While salt in the quantities ordinarily employed will not entirely prevent the decomposition of dairy products by the action of bacteria, it is of decided value in increasing the keeping qualities of butter, and at the same time is free from objections that are urged from a physiological standpoint against the use of many other preservatives. The improvement of flavor is the third and probably the most important purpose fulfilled by salt in the manufacture of American butter.

In cheese making, as in butter making, salt plays an important part. It tends to lessen the water content of cheese, and in so doing exerts an influence upon the ripening process. It is also equally useful in giving the cheese a pleasant flavor. A coarser salt than for butter making is often preferred. The same objections, however, may be urged against the impurities. The presence of chlorids of magnesium and calcium give rise to a bitter taste, and colored specks and other impurities in the salt become apparent in the product and tend to lessen its value.—
H. W. LAWSON.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FERTILIZERS.

Complete fertilizer is one which contains the three essential fertilizing constituents, i. e., nitrogen, phosphoric acid, and potash.

Nitrogen exists in fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrates. It is the most expensive fertilizing ingredient.

Nitrates furnish the most readily available forms of nitrogen. The most common are nitrate of soda and nitrate of potash (saltpeter).

Nitrification is the process by which the highly available nitrates are formed from the less active nitrogen of organic matter, ammonia salt, etc. It is due to the action of minute microscopic organisms.

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble.

Superphosphate.—In natural or untreated phosphates the phosphoric acid is insoluble in water and not readily available to plants. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available to plants. Superphosphates are sometimes called acid phosphates.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water and are believed to be nearly, if not quite, equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvinite, muriate of potash, sulphate of potash, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain, to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorine, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Albuminoids is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are often classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned to furnish heat and energy.

MISCELLANEOUS TERMS.

Micro-organism, or **microscopic organism**, is a plant or animal too small to be seen without the aid of a compound microscope.

Fungus (plural, **Fungi**) is a low form of plant life destitute of green coloring matter; molds and mushrooms are familiar examples. Many diseases of plants are due to fungi.

Bacterium (plural, **Bacteria**) is the name applied in common to a number of different or closely related microscopic organisms, all of which consist of single short cylindrical or elliptical cells or two such cells joined end to end and capable of spontaneous movement. Many kinds of bacteria are harmful and cause diseases and other injurious effects, but many are beneficial. Among the latter are those which give flavor to butter and cheese, and those which enable leguminous plants to use the free nitrogen of the air.

Bacillus (plural, **Bacilli**) is a genus, or kind, of **Bacterium**.

Sterilized milk or cream, properly speaking, is that in which all the germs have been destroyed (usually by repeated heating to 212° F.—boiling point), but in dairy practice the term is applied to milk or cream which has been heated once to a temperature of about 212° F.

Pasteurized milk or cream is that which has been heated to a temperature (about 155° F.) which does not kill all the bacteria, but only those which are in a vegetating condition and ready to begin their activity at once.

Lactation.—The formation or secretion of milk. The “period of lactation” as applied to cows means the length of time since calving that they have been giving milk.

Tuberculin is a liquid in which the germs of tuberculosis have been grown, but from which all live germs of the disease have been carefully removed. It is administered by hypodermic injection as a test for tuberculosis in animals, a rise of temperature after injection indicating the presence of the disease.